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**RESEARCH NOTE**

# CONSTRUCTION PRACTICES AND THEIR RELATIONSHIP TO TERMITE INFESTATIONS

ABDUL HAFIZ, A.M.* and ABU HASSAN, A.

*School of Biological Sciences, Universiti Sains Malaysia*
*Minden 11800, Penang*
**E-mail: abdhafiz@usm.my*
*Phone: (04) 653-4893*

Abdul Hafiz and Abu Hassan (2009) reported the main termites genus causing big economic damages to structure and agriculture crops are the genus *Coptotermes*. The main nest of those species is difficult to distinguish because they are not mound builder termite. Other genera such as *Globitermes, Macrotermes* and *Schedorhinotermes* are also important pest although rarely attacking building (Abdul Hafiz *et al.,* 2007; Abdul Hafiz and Abu Hassan, 2009). Other than economic importance, damage of building constructions by termites rarely investigated in Malaysia (Abdul Hafiz *et al*., 2007, Abdul Hafiz and Abu Hassan 2011). Wood is one of the oldest, most important and versatile building materials and still widely utilized in Malaysia and less well-developed countries, it continue to be only one available material in the future. Termites have long been a serious pest of wooden structures, timber products and other lingo - cellulosic materials, and they are still causing a significant problem in most tropical regions (Abdul Hafiz and Abu Hassan, 2009; Lee and Sajap, 2000).

Current termite control practices in Malaysia are carried out in two distinct phases. The first phase is a pre-construction treatment, where the environment is processed to confer protection against termite attack (Lee and Sajap, 2000). The second one is post construction treatment or remedial treatment of wooden structures damaged by termites (Lee and Sajap, 2000). Prior to the advent synthetic insecticides, early pre-construction treatment was synonymous with good building practices such as adequate ventilation and durable timbers (Su and Scheffrahn, 2000; Verkerk and Bravery, 2001). Proper sanitation included removing all stumps and wooden debris from a building site before and after construction. Adequate ventilation prevented moisture uptake and retention by wood (Lenz *et al.,* 1997; Verkerk and Bravery, 2001). Incomplete compacting of concrete or mortar should be avoided, because it causes flaws-holes and cracks and they permit easy penetration of termites (Peters and Fitzgerald, 1997). Some physical barriers as metal shields or other impenetrable materials force termites into the open and make them detectable (Lenz *et al.,* 1997; Verkerk and Bravery, 2001; Peters and Fitzgerald, 1997).

Mechanical and physical control mechanisms were not always satisfactory and chemical barriers consisting of wood treatment and/or soil treatment with an appropriate chemical was established for both pre-construction and post-construction treatments. Applications of chemicals to the soil are widely employed at present (Lenz *et al.,* 1990, Abdul Hafiz *et al.,* 2007; Abdul Hafiz and Abu Hassan 2011). Chemical pretreatment is a very effective procedure because it provides a toxic barrier against termite movement into wooden structures (Abdul Hafiz and Abu Hassan, 2008). Post-construction treatment is often more expensive and more difficult to apply to the buildings once infested with termites. Post-construction treatments are usually conducted by drilling holes in floors, walls or other structural parts and injecting termiticidal liquids fluid or dust (Su and Scheffrahn, 1996; Su and Scheffrahn, 2000).

The objectives of this study were to determine which construction features were associated with termite infestations and where the point of entry of the termite infestations into the building.

The survey was carried out from 1st April 2005 to 1st May 2006 at 25 houses selected randomly from 14 sites for in two states, Kedah and Pulau Pinang (Table 1 and Table 2). The survey methods described by Abdul Hafiz and Abu Hassan (2009) were applied. Each premise was subjected to two methods of termites's surveys: compound and indoor surveys. Heavy termite infestations were classified

* To whom correspondence should be addressed.

when more than 1000 live worker termites were found from the structure. Meanwhile light infestation was classified when less than 1000 live worker termites were found from the infested structures.

All of the most common structures infested by termites was identified and classified based on building morphology. Structures were classified as permanent, semi-permanent or temporary (Ab Majid, personal communication, January 1, 2005). Permanent structures consisted of concrete or brick (Fig. 1a). Semi-permanent structures consisted of concrete plus timber (Fig. 1b) where as temporary structures consisted of timber only (Fig. 1c). In addition, these were divided into terrace house, semi-detached, and bungalow.

To identify the types of foundation, each structure will be inspected and identified based on the main pillars (beam) that connected to the main base of the floor to the ceiling. The foundation of a structure is defined as that part of the structure that is in direct contact with the ground and which transmits the load of the structure on to the ground. Knowing the foundation and construction types for each structure, it will be easier to detect the main entry points and locate areas to do sub slab chemical injections. Thus, it is easier to control termite efficiently. For this survey, the authors divided the construction types into strip construction, pad construction, and raft construction base on personal communication from registered Malaysian architect Ar. Dr. Ab Majid (Ab Majid, personal communication, January 1, 2005). Strip constructions are normally provided for load bearing walls, and for rows of columns, which are spaced so closely that pad foundation would nearly touch each other (Fig. 2a). Pad construction is usually provided to support structural columns. They may consist of a simple circular, square or rectangular slab of uniform thickness, or they may be stepped or hunched to distribute the load foam heavy columns are sometimes provided with a steel grillage (Fig. 2b). Lastly, raft construction can consist either of massive reinforced concrete slabs or stiff slab and beam cellular raft (Fig. 2c). This kind of construction is for supporting high rise building on unstable ground. On the other hand, according to Reid *et al.* (2005) two predominant types of foundation represented in the structures were either solid or poured concrete or hollow block foundation.

To characterize the infestations, the locations where termite activity was detected were listed as either exterior or interior with respects to construction features. Activity at expansion joints in garages, porches or patios, and planting beds were categorized as exterior (Reid *et al*., 2005). Interior


**Fig. 1.** Building structure in Penang (a) Permanent structure (b) Semi – permanent structure (c) Temporary structure

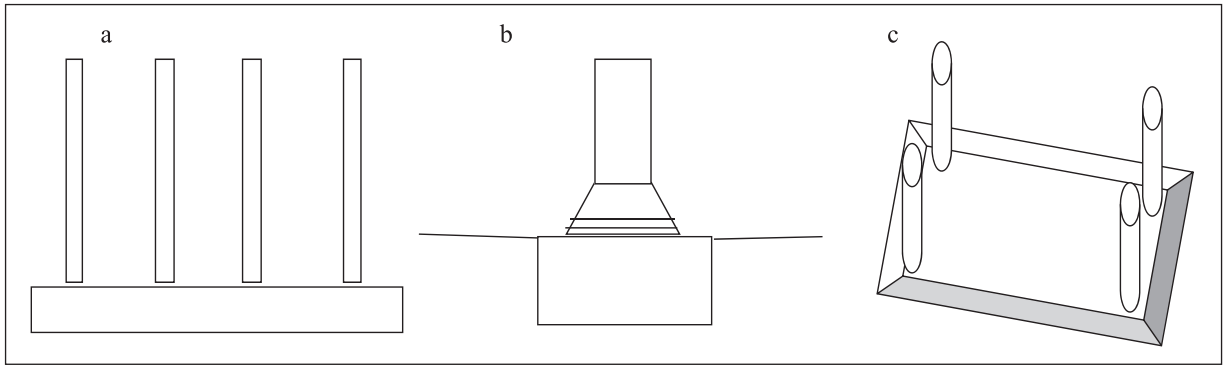


**Fig. 2.** Types of construction foundation (a) strip construction (b) pad construction (c) raft construction

sources of infestations were associated with penetrations of the slab at some distance from perimeter expansion joints, such as in bathrooms, kitchens, or utility rooms (Reid *et al*., 2005). The percentages of infestations were calculated by number of structures infested with termites (sources of infestations) from total of nine infested structures multiply by one hundred.

From the survey, a total of 25 premises from 13 sites were surveyed for termite infestations. The sites includded Bayan Baru, Gelugor, Universiti Sains Malaysia, Sungai Ara, Minden Height, Sungai Batu, Greenlane, Air Hitam, Balik Pulau, Guar Perahu, Mengkuang, Kepala Batas and Sungai Petani. Of the 25 premises only 9 structures were selected due to the treatment conducted to this structure that was infested by economic importance species, *Coptotermes gestroi* only. The rest of the premises survey had no termite infestations. Table 1 shows construction survey among the sites. As a result, 8 structures consist of permanent construction classification. Meanwhile, only one structure consists of semi – permanent construction classification. On the other hand, only one structure consists of temporary construction classification (Table 1).

Mainly from the survey, all the 8 structures were made from pad construction except for Greenlane structure consist of raft construction. Meanwhile, for the foundation type, 7 sites out of 9 structures consist of solid, pour foundation and hollow block foundation consists of 2 structures out of 9. Meanwhile, stone or rubble foundation consists of 1 structure out of 9. Table 2 shows the description of foundation and construction types found in this study.

Outcomes of this classification are shown in Table 3. A common source of exterior infestations, as expected, was the piers and perimeter foundation wall; about 89% of structures had activity on the outer surface of foundation wall, while about 56% of structures had activity associated with inner surface. Among interior sites, the propensity for termites to access the structure by following water and utility lines is evident in the activity noted in the kitchen, bathrooms and utility areas. However, the most common interior sites of activity were identified various living space, including partition walls, door and window frames.

From the survey most of the premises construction infested by termites classified as permanent consist of six sites and it is same for semi permanent construction. Most of the heavy infestations (termites worker >1000) were from the bungalow houses compare to other type of houses. The survey observation shows that heavy infestation comes from bungalow house type. This is due probably of standalone building that was easily opens any source of termite entries toward the building structures. In addition, termites built their way over slab ridge to reach their food source. Also, they could easily enter through a small gap or cracks in step or between step and concrete foundation (Lenz *et al.,* 1997; Verkerk and Bravery, 2001). In every house type, termites could extend their way to reach upper wooden structures by extending tunnels or shelter tubes along the exposed concrete barriers or along the corner between inside column and wood sidings. Furthermore, they were able to produce shelter tubes along the utility pipes in contact with ground and to attack the upper wood members (Verkerk and Bravery, 2001; Peters and Fitzgerald, 1997). Even though the building is double story building, the termites can entry into high-storied buildings from aerial colonies or a pair of alates blown up by wind and establish new colonies as areal nest. In addition, infestation into high-storied buildings is the transportation of termites infested soil or shrubs and trees to the terrace for decorating landscape (Reid *et al.,* 2005; Abdul Hafiz and Abu Hassan, 2009).

On the other hand, most of the sites were pad foundations. Meanwhile, for the foundation type, most of the infested structures were made from solid poured foundation. Probably due to crack and crevices at the foundation can be an entrance or the

**Table 1.** Construction and morphology classification among the sites

| No. | Sites | Construction Classification | Construction Morphology |
|---|---|---|---|
| 1 | Bayan Baru | Permanent | Terrace house |
| 2 | Bertam | Semi-permanent | Bungalow |
| 3 | Guar Perahu | Permanent | Terrace House |
| 4 | Mengkuang | Permanent | Bungalow |
| 5 | Gelugor | Permanent | Bungalow |
| 6 | Kg. Guar Perahu | Semi-permanent | Bungalow |
| 7 | Bayan Lepas | Semi-permanent | Bungalow |
| 8 | Taman Rupawan | Permanent | Bungalow |
| 9 | Greenlane | Permanent | Semi-detached |

**Table 2.** Construction and foundation types among the site

| No. | Sites\Structure | State | Construction type/slab | Foundation type |
|---|---|---|---|---|
| 1 | Bayan Baru | Penang | Pad | Solid, poured foundation |
| 2 | Bertam | Penang | Pad | Solid, poured foundation |
| 3 | Guar Perahu | Penang | Pad | Solid, poured foundation |
| 4 | Mengkuang | Penang | Pad | Solid, poured foundation |
| 5 | Gelugor | Penang | Pad | Solid, poured foundation |
| 6 | Kg.Guar Perahu | Penang | Pad | Stone or rubble foundation |
| 7 | Bayan Leps | Penang | Pad | Hollow block foundation |
| 8 | Taman Rupawan | Penang | Pad | Solid, poured foundation |
| 9 | Greenlane | Penang | Raft | Hollow block foundation |

**Table 3.** Exterior and interior sources of infestation

| Exterior sources of infestation | No. (%) of 9 sites | Interior sources of infestation | No. (%) of 9 sites |
|---|---|---|---|
| Perimeter OFW* | 6 (66.7%) | Bathroom | 4 (44.4%) |
| Perimeter IFW* | 7 (77.8%) | Kitchen | 2 (22.2%) |
| Garage | 2 (22.2%) | Living space | 8 (88.9%) |
| Patio | 5 (55.6%) | Utility room | 3 (33.3%) |
| Porch | 5 (55.6%) | Furnace | 4 (44.4%) |
| Basement wall | 1 (11.1%) | Aerial Colony | 1 (11.1%) |
| Piers/post | 8 (88.9%) | Attic | 2 (22.2%) |
| Planting beds | 1 (11.1) | Other interior | 0 |

* OFW = Outside Foundation Wall, * IFW= Inside Foundation Wall

termites to enter the house (Lenz *et al.,* 1997). Nevertheless, mostly exterior sources of infestation were from piers where the piers were directly connected to the soil as the first basic building constructions before the building foundations were made. Meanwhile the interior sources of infestation came from living space in this study may be due open hollow space within the living room that will give an access for the termites to enter the buildings.

Certain types of building construction practices lead to points of entry for termites into a building structures. Understanding types of construction foundation will help with the control and management of termite infestations by using proper physical protection of the building structures at the beginning of the building construction phase. In addition this research will be a beginning for the building contractors and developers to use certain guideline for developing new building to prevent termite infestations.

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